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Perceptions and practices on antimicrobial use by the farmers of the Chikomba District, Zimbabwe

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ABSTRACT

Knowledge, attitudes, and practices (KAP) on antimicrobial use (AMU) of livestock farmers are poorly understood in Zimbabwe despite their essence in combating the development of antimicrobial resistance. The aim of the study was to assess these patterns based on suggested KAP variables. A questionnaire-based survey of (n=60) Small Scale Commercial Farmers (SSCF), (n=60) Large Scale Commercial farmers (LSCF), and (n=60) resettled farmers (A1) was undertaken from January to March 2019. Participants were purposively selected from 10 wards based on willingness to participate in the study. Logistic regression, analysis of variance, and Pearson's correlation were performed in SAS (2003) version 6. Overall AMU practice scores were above 50% despite detecting violation of manufacturer's specifications. AMU was correlated with farmer's knowledge, r (178) = 0.42, p =0.000 and attitude, r (178) = 0.54, p =0.000. Farming scale, type of livestock kept and level of education influenced AMU (P< 0.05). Farming scale influenced above 50% of the farmers to change label dosages, withdrawal periods, treatment frequencies, and consult friends on AMU. A similar pattern was noted on the effect of main livestock species kept on changing treatment frequencies and the use of human antibiotics. AMU without prescriptions increased with a decreasing level of education (P = 0.010). Knowledge on AMU was high for LSCF (average 58%), low for A1 (average 33%), and SSCF (average 46%). Attitudes were positive for LSCF (average 67%) and SSCF (average 57%) and negative for A1 (average 49%). We concluded that there is a serious violation of antimicrobial manufacturer's specifications by farmers in the Chikomba district which is associated with poor knowledge and attitudes on prudent ways of AMU.

Introduction

There is a drastic global increase in livestock production and Zimbabwe is amongst the countries contributing to such increases. Such increases are positively correlated to several factors, which include improved animal breeding programs, improved animal feeding, and improved health management practices (O'Neill, 2015, Ironkwe *et al*., 2015, Xuan *et al*., 2017). The latter involves the use of antibiotics as therapeutic agents in the treatment of diseases (WAHO, 2018). High levels of animal production have resulted in a corresponding increase in antimicrobial use for therapeutic, prophylaxis, and metaphylaxis purposes (GARP), 2017).

Despite these health benefits associated with antimicrobials, their overuse or misuse may push bacteria into developing antimicrobial resistance, rendering the treatment of many human and animal bacterial diseases complex (WHO, 2018). In clinical terms, AMR often leads to a reduction in the treatment effectiveness of the antimicrobial agents (WHO, 2017, Guo *et al*., 2015; Wall *et al*., 2016). Reducing antibiotic consumption, coupled with more prudent and responsible ways of using them may play essential roles in preventing the emergence of AMR (Farley *et al*., 2018; Levy, 2001; Harada *et al.*, 2008).

Accurate information on the knowledge, attitudes, and practices of farmers on AMU is limited in Zimbabwe (GARP, 2017). The WAHO (2018) recommended quality veterinary provision, regulated access to antimicrobials, and above all monitoring quantities of antimicrobials used in livestock

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production, associated with surveillance of antimicrobial resistance. Zimbabwe, being a member state of OIE responded to these calls by conducting a situation analysis on antimicrobial resistance. Data gathered from the survey was more concentrated on human antimicrobial use, leaving a large gap in livestock production. Along with the objectives of WHO (2018) to reduce AMR through responsible and prudent ways of antimicrobial use in animal production, gathering data on the patterns of antimicrobial use, level of knowledge and attitudes of farmers may help in providing insight on the epidemiology of antimicrobial-resistant pathogens and how they are developing from a particular pattern of antimicrobial use (Ferreira, 2017, Miranda et al., 2008). Such data may include the type of antibiotics used, quantities applied, method of application, and personnel involved in antimicrobial administration. Within the public health context, limitations of such data may affect the chances of fighting AMR. This way, the livestock production sector may be severely undermined through reduced treatment effectiveness of common antimicrobial agents (GARP, 2017).

This information has several implications on various stakeholders responsible for enlightening farmers on the proper antimicrobial use such as reducing antibiotic usage, educating antibiotic users on proper antibiotic usage, increasing levels of biosecurity, and prioritizing vaccination programs in the livestock production sector (Visschers *et al.*, 2015; Ferreira, 2017). Based on this background, this study assessed the patterns of knowledge, attitudes, and practices of farmers on antimicrobial use in livestock, using suggested KAP variables.

Materials and Methods

Study site

The study was conducted in Chikomba district (Figure 1) of latitude: -18.8885^0 or 18^0 53'18.5" south and longitude: 31.0975^0 or 31^0 5'51" east. The region lies in Mashonaland East province, which is located on the North-Eastern side of Zimbabwe.

Survey design and sampling

The study was conducted during the period from January 2019 to March 2019 on a total of 180 respondents (n=60 SSCF, n=60 A1 farms, and n=60 LSCF). Only farmers with layers, beef cattle, and pigs were sampled since such animals are often subjected to antimicrobial agents. They also evenly represented ruminants, poultry, and non-ruminants. A total of n=20 farms for each livestock species were selected from each farming scale. Ten wards were purposively selected from a total of 23 wards under livestock production, based on the availability of all the farming scales in the ward. This information was sought from the district veterinary officer. Participants' selection criterion was premised on a purposive sampling procedure based on whether a farmer uses antimicrobials on his/her livestock, availability of study animal species, and willingness to participate in the study. Para-veterinarians helped in accessing the farmers.

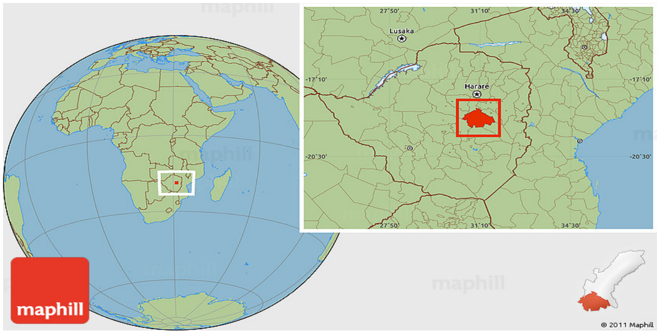

Figure 1. Location of Chikomba district (highlighted in red). Retrieved from www.maphill .com

Research instruments

Questionnaires were crafted by combining knowledge from social scientists and veterinarians. These were then validated in a pilot study. The validity test covered three fundamental sections: content validity (representation of the full content of a definition in a measure), construct validity (measurement for multiple indicators), and reliability (evaluation of measurement accuracy). The pilot study covered 5% of the sample size, conducted on identical respondents but excluding the group to be surveyed. The questionnaire covered general socio-demographic information and KAP patterns on antimicrobial use. The antimicrobial use section was as follows: first section covering antimicrobial use patterns, with never (score= 5), seldom (score= 4), sometimes (score=3), often (score= 2) and always (score=1) as responses; second section testing knowledge of farmers on antimicrobial use with True, False and No idea options (score=1 for a correct answer, 0 for no idea and wrong answer) and the last section capturing attitudes of farmers on antimicrobial use on a 5 point Likert scale with strongly agree (score=1), agree (score=2), neutral (score=3), disagree (score=4) and strongly disagree (score =5) options.

Data analysis

The data were analyzed using a combination of descriptive statistics and statistical tests. Frequencies of responses and the effects of socio-demographic factors on KAP attributes of farmers were analyzed by the PROC FREQ procedure and the LOGISTIC procedure (Cumulative logit) of SAS (2003) version 6, respectively. One way Analysis of Variance with a Tukey post hoc test was used for comparison of variance in total KAP scores. Pearson's correlation analysis assessed the degree of correlation between antimicrobial use practice scores and knowledge and attitude scores. Significance level was set at P<0.05.

Results

Socio-demographic characteristics and Antimicrobial usage patterns of farmers

The socio-demographic characteristics for n=180 farmers are presented in Table 1. None of the socio-demographic characteristics was associated with farming scale. Males constituted the greatest proportion of the farmers (80%) than females, across all farming systems. Most of the farmers were 65 years and above (42% of the total population). Christianity was the predominant religion (95%) followed by farmers. All of the farmers had at least basic primary education.

Frequencies of antimicrobial use practices are presented in Figure 2. The results indicate that more than half of the farmers (52%) used antibiotics on animal species not stated on the product label list. Similarly above 50% of the respondents used antibiotics on diseases not stated on the product label list. It was also apparent that the majority of the farmers (73%) used dosage levels not stated on the product label list. More than 50% of the respondents changed treatment frequencies stated on the product label. A more similar proportion of the farmers reported that they changed product label withdrawal periods. Consultation of friends on the choice of antimicrobial to use, use of prescription-only antimicrobials without prescriptions, extension of treatment frequencies, and use of antibiotics for prevention of diseases, were also common practices among the farmers as more than 50% of them engaged in such practices. The greatest proportion of farmers neither used human antibiotics on animals (71%) nor antibiotics for growth promotion (58%).

Table 1. Socio-demographic characteristics of farmers

Item	A1 (n=60)	SSCF (n=60)	LSCF (n=60)	Statistical test	
	Percent	Percent	Percent	χ^2	P-value
Sex:					
Male	72	85	83	3.96	0.14
Female	28	15	17		
Age:					
18-34 years	12	18	18	19.22	0.42
35-64 years	37	47	38		
≥65 years	51	35	44		
Religion:					
Christianity	88	95	95	2.65	0.27
African tradition	12	5	5		
Education:					
Primary	5	7	2	31.30	0.71
Secondary	62	65	65		
Tertiary	33	28	33		

Note: A1 resettled farmers; SSCF, Small Scale Commercial Farmers; LSCF, Large Scale Commercial Farmers

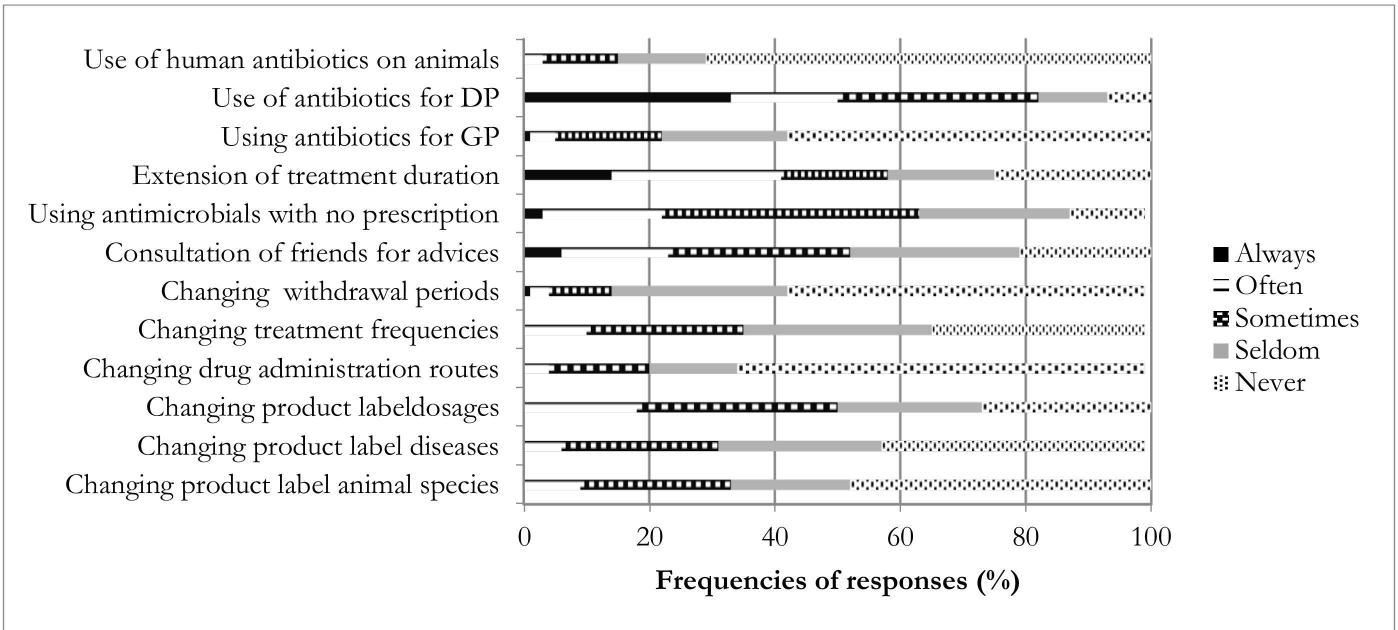

Figure 2. Distribution of responses (always, often, sometimes, seldom, and never) among farmers in Chikomba district (n=180) based on suggested measures on antimicrobial usage. GP, growth promotion; DP, disease prevention

Table 2. Effect of socio-demographic factors on antimicrobial use patterns

Demographic factor	Antimicrobial use variable	β(SE)	P-value for β	OR	(95%) CI
Farming scale	Changing product dosage levels	1.13(0.10)	<.0001	3.10	2.11-4.56
	Consultation of friends for treatment	1.01(0.19)	<.0001	2.75	1.89-3.99
	Extension of product treatment duration	1.65(0.21)	<.0001	5.19	3.42-788
	Use of human antibiotics on animals	1.38(0.27)	<.0001	3.98	2.36-6.70
	Change of product withdrawal periods	0.93(0.21)	<.0001	2.54	1.68-3.85
Type of animals species kept	Extension of product treatment duration	0.47(0.18)	0.0080	1.60	1.13-2.25
	Use of human antibiotics on animals	-0.64(0.24)	0.0075	0.52	0.33-0.84
Level of education	Use of prescription-only antimicrobials without prescription	0.66(0.26)	0.0103	1.94	1.17-3.21

NB: Only variables with P< 0.05 are included in the table. β, beta value; CI, confidence interval; OR, odds ratio

Table 3. Effect of socio-demographic factors on antimicrobial use knowledge

Demographic factor	AMU knowledge factor	β(SE)	P-value for β	OR	95% CI
Farming scale	Antibiotics can treat viral diseases	0.77(0.19)	<.0001	2.16	1.48-315
	There are no side effects associated with antibiotic usage on animals	0.82(0.20)	<.0001	2.26	0.53-3.35

NB: Only variables with P < 0.05 are included in the table. β, beta value; CI, confidence interval; OR, Odds ratio; AMU, Antimicrobial Usage

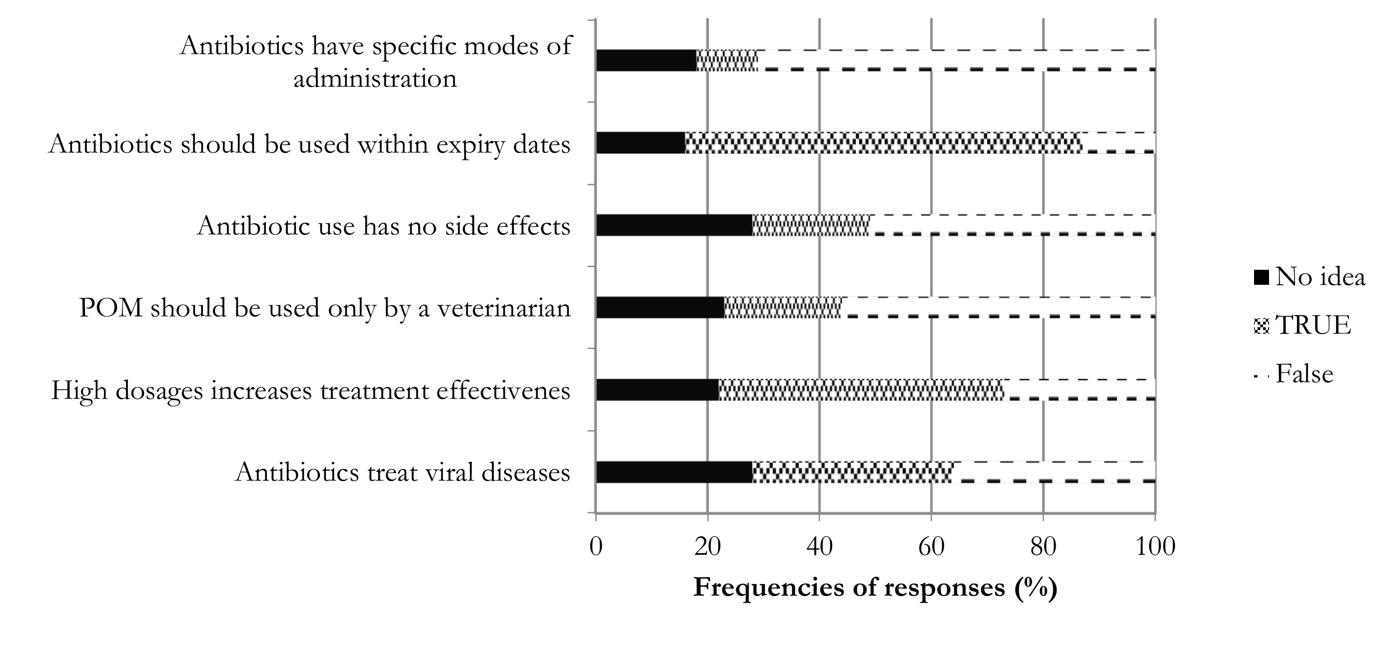

Figure 3. Distribution of responses (true, false, and no idea) among farmers in Chikomba district (n=180) based on suggested knowledge measures on antimicrobial usage. POM, Prescription-only-antimicrobials.

The maximum likelihood estimates for the effects of demographic factors on antimicrobial use practices are presented in Table 2. Estimates were determined in descending order as follows: LSCF, SSCF, and A1 farmers. Age, sex, religion, and animal production experience did not affect (P > 0.05) on any of the antimicrobial use practices, while the level of education, main livestock species kept and farming scale had effects on at least one of the antimicrobial use practices. Farming scale influenced the tendency of farmers to use dosage levels not specified by the drug manufacturer (P = 0.001), where the tendency increased from LSCF, SSCF to A1 farmers by a coefficient of 3.10 times. There was a 2.75 times likelihood increase in consultation of friends, without having to see a veterinarian on the choice of antimicrobial to use from LSC, SSCF to A1 farmers. A1 farmers were 5.19 times more likely to extend treatment duration stated on the antimicrobial container if an animal failed to recover than SSCF and 10.38 times than LSCF while SSCF was 5.19 times more likely to do the same than LSCF. The likelihood of using human antibiotics on animals increased by a coefficient of 2.54 from LSCF to A1 farms. The practice of changing product label withdrawal periods increased by 2.54 times from LSCF to A1 farmers. Main livestock species kept by the farmer influenced the tendency of extending treatment duration stated on the product label in the case of animals that fail to recover within the stated periods (P= 0.008) and the tendency to use human antibiotics (P= 0.007), were the former increased by a coefficient of 1.60 times from pig farmers to beef and poultry farmers and the later increased by 0.52

times from pig farmers to beef and poultry farmers. The level of education of the farmers affected the practice of using prescription-only antimicrobials without a prescription (P= 0.010), where the likelihood to engage in the practice increased by 1.94 times from farmers with tertiary education to those with primary education.

Knowledge levels of farmers on antimicrobial use and their association with socio-demographic factors

The proportions of responses of farmers to antimicrobial use knowledge questions are shown in Figure 3. The majority of the respondents (64%) had the general misconception that antibiotics can treat viral diseases. The greatest proportion of farmers (51%) believed that increasing antimicrobial dosages improve treatment effectiveness. About 44% of the respondents did not know that prescription-only antimicrobials should only be used by a veterinarian or under his or her supervision. Similarly, most of the farmers believed that there are no side effects associated with using antibiotics on animals. Regarding the use of expired antimicrobials, 71% of the farmers were knowledgeable that they should not be used. The administration of antibiotics through any means was regarded as malpractice by the majority of the respondents (71%).

Table 3 presents the odds ratio estimates for the effects of demographic factors on knowledge score. Only farming scale affected the knowledge of farmers on whether antibiotics can treat viral diseases ($P < 0.001$) and whether there are no side effects associated with using antibiotics ($P < 0.001$). The general misconception that antibiotics can treat viral diseases differed with a coefficient of 2.16 times between LSCF and SSCF and 4.32 times between LSCF and A1 farmers. A1 farmers believed that there are no effects associated with using antibiotics, 2.16 times more than SSCF, and 4.32 times more than LSCF.

Attitudes of farmers on antimicrobial use and their association with socio-demographic factors

The majority of the farmers (54%) had a positive attitude towards heavy reliance on antibiotics to improve livestock production (Figure 4). A small proportion of the respondents believed that antibiotics can treat any disease condition. Above 50% of the respondents had a negative attitude towards keeping antimicrobials at home in case there is an urgent need to use them. The majority of the respondents preferred acquiring antibiotics from relatives sometimes without having to see a veterinarian. Regarding their attitude towards using large antibiotic dosages to ensure quick recovery of sick animals, the majority of the farmers (55%) were positive. About 48% of the respondents were more positive about using oral antimicrobials than their injectable counterparts.

The odds ratio estimates for the effects of socio-demographic characteristics on antimicrobial use attitude are presented in Table 4. There was no significant association between age, sex, and level of education and the antimicrobial use attributes. The belief that heavy use of antibiotics improves animal production increased with a coefficient of 1.61 from LSCF to A1 farmers. Similarly, A1 farmers were 4.46 times more likely to believe that antibiotics can treat any disease condition than SSCF and 8.92 more than LSCF. The preference to keep antibiotics at home in case there is an urgent need to use them increased with a coefficient of 1.69 from A1 to LSCF. A1 farmers preferred using antibiotics administered through the oral route more often with a coefficient of 2.32 times greater than SSCF and 4.64 times more than LSCF. Christians felt it is sometimes the best practice to acquire antibiotics from relatives, without having to see a veterinarian, 2.04 times more than African tradition believers.

Average total KAP scores of farmers on antimicrobial use

It was observed that there was at least a significant difference within groups (A1, SSCF, and LSCF) in total scores for knowledge, attitudes, and practices on antimicrobial use (Table 5). Encouragingly, all farming systems exhibited good antimicrobial use practice (mean score above 50% of the total score) although the mean score was significantly higher for LSCF ($P=0.000$) than both SSCF and A1 farmers. A similar pattern was also evident, where antimicrobial use practice scores varied significantly ($P< 0.05$), between SSCF and A1 farmers. The levels of knowledge of A1 farmers on antimicrobial use were generally poor (33%) and they were significantly lower than SSCF ($P = 0.000$) and LSCF ($P = 0.000$). SSCF also demonstrated little knowledge of antimicrobial use than LSCF ($P = 0.001$). The attitudes of all farmers towards antimicrobial use, patterns were generally good (mean scores above 50% of the total score) and these differed significantly across all farming systems, with LSCF exhibiting more positive attitudes, SSCF moderately positive and A1 farmers showing lesser positive attitudes.

The level of knowledge on antimicrobial use exhibited by farmers was moderately positively correlated with antimicrobial use practice, r (178) = 0.42, p =0.000. A strong positive correlation was also evident between the attitude and practice of antimicrobial use, r (178) = 0.54, p =0.000.

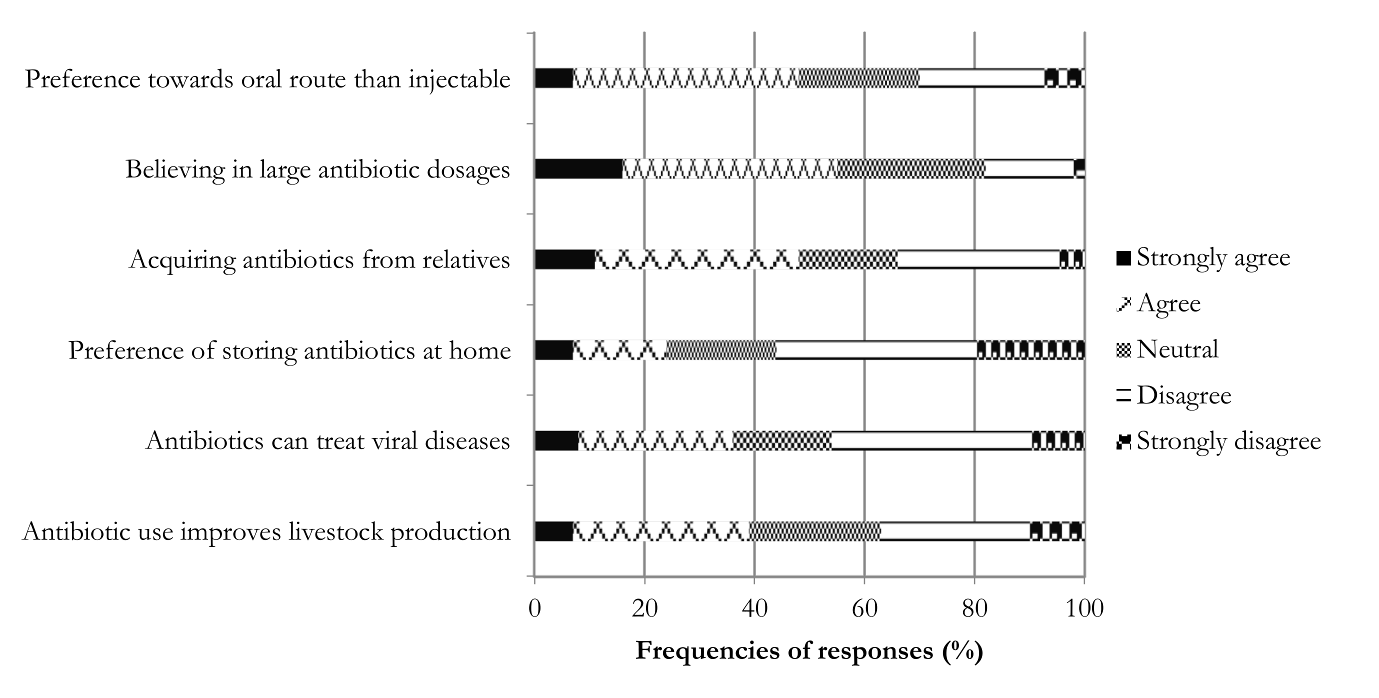

Figure 4. Distribution of responses (strongly agree, agree, neutral, disagree, and strongly disagree) among farmers in Chikomba district (n=180) based on suggested attitude measures on antimicrobial usage.

Table 4. Effect of socio-demographic factors on farmer's attitude towards antimicrobial use

Demographic factor	Attitude on AMU variable	β(SE)	P-value for β	OR	(95%) CI
Farming scale	Heavy use of antibiotics can improve livestock production	0.47(0.18)	0.0090	1.61	1.12 - 2.29
	Antibiotics can treat any disease condition	1.49(0.21)	<.0001	4.46	2.94 - 6.77
	Keeping antibiotics at home is good	0.53(0.18)	0.0035	1.69	1.19 - 2.41
	Using oral route rottenly	0.84(0.19)	<.0001	2.32	1.60 - 3.37
Religion	It is good to get antibiotics from relatives	0.71(0.33)	0.0299	2.04	1.07 - 3.89

NB: Only variables with P< 0.05 are included in the table. β, beta value; CI, confidence interval; OR, odds ratio; AMU, Antimicrobial Usage

Table 5. Average KAP scores on antimicrobial use, antimicrobial resistance, and waste disposal

Antimicrobial usage variable	Possible score	Mean ± SE			ANOVA	
		A1	SSCF	LSCF	F-value	P-value
Practice	60	41.18±0.5[a]	44.47±0.44[b]	50.37±0.43[c]	103.4	0.000
Knowledge	6	1.95±0.15[a]	2.77±0.16[b]	3.5±0.13[c]	28.4	0.000
Attitude	30	14.83±0.37[a]	17.2±0.32[b]	20.18±0.30[c]	66.2	0.000

[abc]Means in the same row without common superscript are different at P<0.05. SE, Standard error; A1, resettled farmers; SSCF, Small Scale Commercial Farmers; LSCF, Large Scale Commercial Farmers; AMU, Antimicrobial Usage.

Discussion

Although antimicrobial use practices were generally good (scores above 50%), there was much evidence of farmers using antimicrobials without adhering to manufacturer specifications. Such practices are contrary to what Weese *et al.* (2006) and Reyher *et al.* (2017) regarded as prudent use of veterinary agents, which they characterized as careful selection of antimicrobials to use, dosage level, and duration of therapy. That was also antagonistic to the guidelines for responsible and prudent use of veterinary drugs by farmers OIE (2015), which stipulates maximum adherence to the manufacturer's specifications when using antimicrobials. Interestingly, antimicrobial use patterns were correlated with farmers' knowledge level and attitude, contrary to what was reported by Huang *et al.* (2013) that there lacked association between those variables and antimicrobial use practices. Stakeholders responsible for enlightening farmers on proper ways of using antimicrobials may take this as an opportunity to educate farmers on antimicrobial use.

Violations of product label withdrawal periods as observed in this study have also been reported in related studies (Adesokan *et al.,* 2015; Amaechi, 2014; Nonga *et al.*, 2010). The same studies attributed such tendencies of antimicrobial use to most of the reported cases where partially metabolized antibiotics were detected in animal products such as meat, milk, and eggs. We also found out that the majority of the farmers (73%) reported that they changed product label dosage levels. This differed from what was earlier reported by Ndlobvu and Masika (2016) that farmers in Zimbabwe indicated that they adhered to the manufacturer's specifications. While his reports were specific to antimicrobial use practices on *Bovine dermatophilosis*, this study captured general antimicrobial use patterns, which might have been the source of variation in observations. More so, our observation corresponds with farmers' knowledge and attitudes, that large dosages ensure quick recovery of sick animals.

The tendency of extending treatment frequencies is consistent with the statements of Adesokan *et al.* (2015) that respondents continued using the same antibiotics despite showing signs of non-responsiveness to treatment. In clinical terms, such non-responsiveness to medication is often a result of AMR. The practice of using prescription-only antimicrobials without prescriptions is typical of the earlier postulations by Chiduwa *et al.* (2008) that veterinary support is generally poor in the majority of Southern African countries. Poor knowledge within farmers on antimicrobial use, coupled with weak enforcement of restrictive policies on access to such antimicrobials without prescriptions might have fueled such a practice. Encouragingly respondents had a negative attitude towards storing antimicrobials at home, like what was reported by Jifar and Ayele (2018). It could be imperative to take advantage of such a positive attitude to educate the farmers on the dangers of free access to antimicrobials.

High incidences of preventative use of antimicrobials in livestock were also reported by Ishak *et al.* (2018). Sub-therapeutic dosages of antimicrobials given to animals when preventing diseases foster the development of AMR (Jonston, 1998; O'Neill, 2015; Speksnijder *et al.,* 2015). Encouragingly the greatest proportion of farmers neither used human antibiotics for treatment of livestock infections (71%) nor antibiotics for growth promotion. This is along with the recommendations of WHO (2017) to reduce the use of antimicrobial agents used in human medicine in livestock. A few recorded cases of using human antibiotics on livestock as shown in A1 farms suggest a severe lack of veterinary services in such areas (GARP, 2017).

Variations in the antimicrobial use practices within farming scales are in agreement with earlier statements of Adesokan *et al.* (2015) and Sadiq *et al.* (2018) that patterns of using antimicrobials vary from farmer to farmer since they use their knowledge to use the antimicrobials. Generally, the overall poor knowledge and attitude scores on antimicrobial use observed in this study are consistent with the 11 % knowledge level identified in Kosovo (Zajmi *et al.*, 2017). Such findings suggest a need to educate farmers on antimicrobial use in Zimbabwe. Priority could, therefore, be given on resettled farmers who exhibited a pattern of using antibiotics against manufacture specifications than other farming scales. Similarly, such farming areas can be areas of concern regarding the provision of veterinary support, following the antimicrobial usage tendencies observed in this study. In light of the effects of education on antimicrobial use practices, where farmers who had only primary education were more likely to use antibiotics without prescriptions than those with higher education, it could be a noble idea to incorporate basic antimicrobial use learning content in primary education curricula.

Conclusions

The study revealed that most of the farmers generally exhibited good antimicrobial use practices; however A1 farmers were noted to use antimicrobials without adhering to manufacturer's specifications than other farming scales. Antimicrobial use practices were positively correlated with knowledge and attitudes on antimicrobial use. There were a few reports on the use of human antibiotics on animals, of which the few reports were more confined within resettled farms. Therefore, we conclude that there is a serious violation of manufacturer's specifications on the use of antimicrobial agents in Chikomba district, which is attributed mostly to the level of knowledge and attitude of the farmers on antimicrobial usage.

Declarations of interest

The author(s) declare that there is no conflict of interest with regards to the research, authorship and/ or publication of this article.

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